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HETEROSIS IN PREWEANING AND WEANING TRAITS AMONG CROSSES OF THE HEREFORD, ANGUS, AND CHAROLAIS BREEDS

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HETEROSIS IN PREWEANING AND WEANING TRAITS AMONG CROSSES OF THE HEREFORD, ANGUS, AND CHAROLAIS BREEDS[1]

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INTRODUCTION

Crossbreeding as a system of breeding may be an effective means to improve beef production. Gerlaugh et al. (1951) found that Angus × Hereford calves and their reciprocal crosses were heavier at weaning and outgained their purebred contemporaries from birth to weaning. Swanson et al. (1966), in studies with Hereford and Angus cattle, found that the weaning weights of the crossbreds exceeded those of the straightbreds in both sexes. Studies by Damon et al. (1959) in the Gulf Coast region indicated that crossbred calves sired by Charolais bulls were consistently heavier at weaning and that the greatest heterotic responses occurred when Brangus and Brahman females were used. A review of the performance of Charolais-sired calves in Louisiana crossbreeding studies by Temple (1960) indicated that the breed has a promising potential for improving overall beef production. Other reports by Temple et al. (1960, 1961) cite significantly higher crossbred performance levels for number of calves born and raised, as well as for weight and grade of calves at weaning. These reports (i) noted that Hereford and Charolais bulls sired calves that were considerably heavier at weaning and (ii) recognized the value of Brahman breeding in the cow for superior mothering ability under Southeastern conditions. Cartwright (1962), in studies involving the British and Brahman breeds, noted a 25.6% advantage for backcross calves in weaning weights. Gregory et al. (1965) observed significant heterotic effects among crosses of the Hereford, Angus, and Shorthorn breeds for birth weight, preweaning gain, weaning weight, and weaning conformation score.

The objective of this report was to study the importance of heterosis on preweaning and weaning traits among crosses of the Hereford, Angus, and Charolais breeds.

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[1] This study was conducted under Western Regional Project W-1, "The Improvement of Beef Cattle Through the Application of Breeding Methods."

MATERIALS AND METHODS

The data were collected at the Mealani Experiment Station, Kamuela, Hawaii, over a 4-year period from 1965 through 1968. The foundation cow herd was purchased from two local ranches and consisted of 60 grade Hereford and 35 grade Angus heifers. All females were 2 years old at their first breeding in 1965. Additional Angus heifers from the original source were added for the 1966 and 1967 breeding seasons. Purebred Hereford, Angus, and Charolais bulls, obtained from both local and mainland sources, were used. The Hereford and Angus bulls sired both straightbred and crossbred calves; whereas, the Charolais bulls sired only crossbred progeny. Replacement bulls were selected each year from as many different lines of breeding as possible in order to provide a more representative sample of the breeds involved. The initial breeding herds were composed of cows assigned at random to single-sire breeding groups. All cows were rotated from one breeding group to the next in each succeeding year of the experiment, thereby giving all females an opportunity to be mated to bulls of different breeds. Cows were culled from the breeding herd on the basis of proven sterility, accidental injury, or disease. The experimental design showing the number of cows exposed annually to bulls is presented in Table 1. The total number of calves weaned each year by breeding groups and sex class is shown in Table 2.

Cows were exposed each year to one sire only for a 75-day breeding period starting on April 1. Calves were born the following year from early January to late March and remained with their dams on pasture until weaning in late September. Body weights were obtained on all calves within 24 hours after birth. Male calves were castrated at about 3 months of age. Weaning weights were taken at about 8 months of age and were adjusted to 240 days of age by using the calf's own preweaning daily gain. The conformation

TABLE 1. Experimental design and number of cows exposed annually to bulls

Breed of dam	Year											
	1965 Breed of sire[a]			1966 Breed of sire			1967 Breed of sire			Total Breed of sire		
	H	A	C	H	A	C	H	A	C	H	A	C
	Number											
Hereford	19	17	22	19	18	19	18	19	18	56	54	59
Angus	10	15	7	15	14	16	19	20	19	44	49	42
Total	29	32	29	34	32	35	37	39	37	100	103	101

[a] Two bulls of each breed were used each year. H=Hereford, A=Angus, C=Charolais.

TABLE 2. Number of calves weaned, by year, breeding group, and sex class

Breed of dam	Year	Breed of sire						Total	
		Hereford		Angus		Charolais			
		M[a]	F	M	F	M	F	M	F
		Number							
Hereford	1966	8	5	8	7	6	12	22	24
	1967	10	8	10	8	6	11	26	27
	1968	9	6	8	7	11	7	28	20
	Total	27	19	26	22	23	30	76	71
Angus	1966	4	5	7	4	2	2	13	11
	1967	4	8	4	9	5	8	13	25
	1968	8	10	8	9	6	12	22	31
	Total	16	23	19	22	13	22	48	67
Total, all calves		43	42	45	44	36	52	124	138

[a] M=male, F=female.

score assigned to each calf at weaning represents the average grade given by a committee of three graders. The scoring system used is described in Table 4. All cows and calves from the different breeding groups were handled under the same management routine until weaning. A mineral mixture containing salt, calcium, phosphorus, and trace minerals was available to all animals at all times.

Heterosis was measured by comparing the performance of crossbred calves with the average performance of straightbred calves. The preweaning data were summarized separately for each sex, thereby eliminating any bias due to sex effects. Age-of-dam effects were not considered in this summary because almost all of the cows in any given year were the same age. Because only straightbred Hereford and Angus calves were available as controls in this experiment, the term "heterosis" will be confined to comparisons between straightbred calves and crossbred calves in the Hereford × Angus and reciprocal crossbreeding groups. The performance of Charolais-sired calves will be referred to as crossbred superiority.

RESULTS AND DISCUSSION

The average performance for calves in the various breeding groups is presented in Table 4.

Crossbred calves averaged heavier weights at birth than did the straightbreds. Heterotic effects in the Hereford × Angus and reciprocal cross calves

amounted to 4.1% for males and 5.7% for females. Gregory et al. (1965) reported similar heterotic effects for birth weight among crosses of the Hereford, Angus, and Shorthorn breeds. Pahnish et al. (1969) reported 4.4% heterosis for steer calves and 1.4% for heifer calves among crosses of the Hereford, Angus, and Charolais breeds. A considerably higher response was observed by Ellis et al. (1965), who reported 10.8% heterosis in first-cross calves from reciprocal matings of the Hereford and Brahman breeds. The crossbred advantage for Charolais-sired calves in this study amounted to 21.9% for males and 12.9% for females; the advantage for all crossbreds combined was 12.3% and 10.0% for males and females, respectively.

Most of these differences in birth weight (Table 4) resulted from the fact that straightbred Angus calves were consistently the lightest at birth; whereas, Charolais-sired calves were the heaviest. Straightbred Hereford calves were comparable in birth weight to calves in the Hereford-Angus reciprocal crosses. The range in birth weights covered a wide span, from 42 pounds to 116 pounds. The lightest calf was a straightbred Angus male, the third calf produced by its 5-year-old dam. The heaviest calf was sired by a Charolais bull and out of a 4-year-old Hereford cow.

Death loss at calving was the highest (12.5%) during the first calving season in 1966, when all dams were 3-year-old primigravid heifers (Table 3). Anderson and Bellows (1967) reported significantly higher calf mortality at birth among 3-year-old first-calf heifers. The present study indicated that heavy birth weights were not a major factor responsible for stillbirths.

TABLE 3. Calf mortality at birth by breeding group, year, and sex

Breeding group[a]	1966		1967		1968		Total		Percent loss		
	M[b]	F	M	F	M	F	M	F	M	F	Total
	Number								%		
H × H	4	1	0	0	1	0	5	1	15.6	4.8	11.3
A × A	0	0	0	0	1	1	1	1	5.0	4.3	4.6
H × A	0	0	2	1	0	0	2	1	11.1	4.2	7.1
A × H	0	0	0	0	0	0	0	0	0	0	0
C × H	0	3	1	1	0	0	1	4	4.2	11.8	8.6
C × A	2	0	1	0	1	0	4	0	23.5	0	10.3
Total no.	6	4	4	2	3	1	13	7			
% loss	14.6	10.2	9.3	3.7	5.6	1.9	9.4	4.8	9.4	4.8	
Average % loss	12.5		6.2		3.7		7.0		7.0		

[a] Breed of sire shown first. H=Hereford, A=Angus, C=Charolais.

[b] M=male, F=female.

TABLE 4. Birth weight, daily gain, weaning weight, and conformation score of calves, by breeding group, year, and sex class

Breeding group[a]	Year	Birth weight, pounds		Daily gain, birth to weaning, pounds		Adjusted[b] weaning weight, pounds		Conformation score[c]	
		Male	Female	Male	Female	Male	Female	Male	Female
H × H	1966	77	70	1.46	1.22	429	368	11.2	11.4
	1967	79	72	1.68	1.59	482	452	11.5	11.4
	1968	77	81	1.46	1.57	428	457	11.0	12.0
	Average	78	74	1.54	1.49	448	432	11.3	11.6
A × A	1966	63	66	1.32	1.27	380	370	11.0	10.8
	1967	72	64	1.82	1.64	509	458	11.5	11.9
	1968	64	66	1.56	1.57	439	444	10.5	11.7
	Average	66	65	1.53	1.54	432	436	10.9	11.6
H × A	1966	71	69	1.59	1.42	453	408	11.0	11.0
	1967	75	69	1.83	1.60	514	452	11.5	11.4
	1968	79	77	1.71	1.65	491	473	11.6	11.9
	Average	76	72	1.71	1.58	487	452	11.4	11.5
A × H	1966	72	76	1.45	1.25	421	376	11.5	10.7
	1967	78	69	1.74	1.65	495	464	11.5	12.0
	1968	79	77	1.74	1.56	498	453	11.8	11.1
	Average	76	74	1.65	1.50	473	433	11.6	11.3
C × H	1966	82	77	1.54	1.32	451	388	11.3	11.2
	1967	88	82	2.0	1.64	568	474	11.3	11.1
	1968	94	87	1.78	1.56	521	462	11.7	11.0
	Average	89	81	1.77	1.49	515	437	11.5	11.1
C × A	1966	83	68	1.60	1.59	472	450	10.5	11.5
	1967	92	73	2.01	1.79	573	502	11.6	11.8
	1968	87	80	1.76	1.69	511	486	11.5	11.5
	Average	88	77	1.83	1.72	529	489	11.4	11.6
All straightbreds		73	70	1.54	1.52	442	434	11.1	11.6
H-A crossbreds		76	74	1.67	1.54	478	442	11.5	11.4
Cross advantage, %		4.1	5.7	8.4	1.3	8.1	1.8	3.6	–1.7
C-sired crosses		89	79	1.80	1.59	520	459	11.5	11.3
Cross advantage, %		21.9	12.9	16.9	4.6	17.6	5.8	3.6	–2.6
All crossbreds		82	77	1.73	1.57	498	451	11.5	11.4
Cross advantage, %		12.3	10.0	12.3	3.3	12.7	3.9	3.6	–1.7

[a] Breed of sire is listed first. H=Hereford, A=Angus, C=Charolais.

[b] Adjusted 240-day weight = weaning weight + ADG (240 − weaning age), where ADG = average daily gain from birth to weaning.

[c] Conformation score based on feeder grades where 17, 16, 15 = Prime; 14, 13, 12 = Choice; 11, 10, 9 = Good; etc.

Heifer calves born dead averaged 12 pounds heavier than the average birth weights of all female calves born alive; male calves born dead averaged 4.2 pounds lighter than those born alive. Woodward and Clark (1959) and Anderson and Bellows (1967) reported heavier birth weights for calves born alive and concluded that heavy birth weight was not a major cause of stillbirths. Koger et al. (1967) stated that birth weight of calf had a highly significant quadratic effect on survival, with intermediate birth weights being associated with higher survival rate than either low or heavy birth weights. Death loss reported herein was reduced by one-half in the 1967 calving (6.2%) and was further reduced to 3.7% in the 1968 calving. Birth weights, however, remained constant or increased slightly with each successive calving season. Average annual death losses at birth reported in other studies include 3.6% (Woodward and Clark, 1959), 4.7% (Anderson and Bellows, 1967), and 7.4% from data presented by Wiltbank et al. (1961). In the present study, a slightly higher proportion of straightbred calves was born dead but this difference was not significant. Males comprised 65% of total stillbirths although only 48.6% of all calves born were males. The relationship between sex of calf and number of stillbirths was not significant.

Crossbred calves maintained a fairly consistent advantage over straightbreds in average daily gain from birth to weaning. Crossbred males averaged 1.73 pounds per day versus 1.54 pounds for the straightbreds, an advantage of 12.3%. Charolais-sired male calves, with somewhat higher daily gains of 1.80 pounds, exhibited a crossbred superiority of 16.9%. Male calves from the Hereford $\times$ Angus reciprocal crosses showed 8.4% heterosis. Considerably lower levels of crossbred superiority were observed for heifer calves: 3.3% for all crossbreds, 4.6% for Charolais-sired heifers, and 1.3% for calves in the Hereford $\times$ Angus reciprocal crosses.

Weaning weight followed a pattern very similar to that of preweaning growth rate. The average performance of all crossbreds exceeded that of the straightbreds by 56 pounds for males and 17 pounds for females. This represents a crossbred advantage of 12.7% and 3.9% for males and females, respectively. Calves in the Hereford $\times$ Angus reciprocal crosses outweighed their straightbred counterparts by 36 pounds for males and 8 pounds for females. Heterotic effects for these calves amounted to 8.1% and 1.8% for males and females, respectively. Pahnish et al. (1969) reported similar levels of heterosis for weaning weight among crosses of the Hereford, Angus, and Charolais breeds. Charolais-sired calves in the present study averaged the heaviest weaning weights; male calves were 78 pounds heavier than straightbreds (17.6% advantage) and female calves averaged 25 pounds heavier (5.8% advantage). This is consistent with findings of Damon et al. (1959), who reported that Charolais bulls repeatedly sired calves with heavier weaning weights.

Conformation score at weaning did not show a significant response to system of breeding. Straightbred females had a slightly higher average score than crossbred females, 11.6 versus 11.4. The reverse was true for male calves; crossbreds averaged 11.5 as compared to 11.1 for straightbred males. Other studies, however, have reported significant levels of heterosis for weaning conformation score; these include reports by Gregory et al. (1965) involving the Hereford, Angus, and Shorthorn breeds and by Pahnish et al. (1969) involving the Hereford, Angus, and Charolais breeds.

SUMMARY

Three years' calving data collected on 138 male and 146 female calves at the Mealani Experiment Station, Kamuela, Hawaii, were studied to measure response in preweaning and weaning traits resulting from crossing the Hereford, Angus, and Charolais breeds of cattle. Straightbred Hereford and Angus calves were compared to Hereford × Angus and reciprocal crosses, and to Charolais × Hereford and Charolais × Angus crossbred calves. Data from steers and heifers were treated separately. The effect of age of dam was not considered since almost all cows were the same age in a given year. Records on birth weight, calf mortality at birth, preweaning daily gain, weaning weight, and weaning score were included in the study.

Crossbred superiority was evident for birth weight, preweaning daily gain, and weaning weight. Charolais-sired calves were consistently heavier at birth; straightbred Hereford calves were comparable in birth weight to Hereford × Angus reciprocal cross calves. The advantage for birth weight in all crossbred calves combined amounted to 12.3% for males and 10.0% for females. Steer calves exhibited significantly higher levels of response for preweaning daily gain and for weaning weight than did heifer calves. Crossbred advantage for preweaning daily gain amounted to 12.3%, 16.9%, and 8.4% for males and 3.3%, 4.6%, and 1.3% for females in all crossbreds combined, Charolais-sired calves, and Hereford × Angus reciprocal crosses, respectively. Similar data for weaning weight were 12.7%, 17.6%, and 8.1% for males and 3.9%, 5.8%, and 1.8% for females, respectively. Conformation score at weaning and calf mortality at birth did not appear to be influenced by system of breeding.

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